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SUMMARIES OF SYMPOSIA BY:

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Roger Sperry *(California Institute of Technology, Pasadena)* considered the question of whether there exist, after commissurotomy, two separately conscious minds sharing one brain. If this is indeed the case, what does this circumstance signify for the substrate of awareness and the unity of the mind in the normal active brain?

Postoperative patients appear to be normally unified individuals while performing routine, nonlateralized activities. Despite the apparent coherence of behavior and personality in these patients, control testing in the laboratory for independent functioning of each hemisphere shows that the mind, as well as the brain, has been divided. These people function with two separate streams of subjective awareness, one in each hemisphere.

For example, if an object is presented out of sight to the right hand (left hemisphere), the patient can immediately identify it verbally. If an object is presented instead to the left hand (right hemisphere), the patient cannot tell you what it is but can correctly pick it out from among several objects, but only with the left hand. This test can be performed with both hand-hemisphere combinations working in parallel, and it can be seen that each hand feels and rejects the items the other hand is looking for. If the patient is shown a composite stimulus of two half faces, one on either side of the midline, each half is separately completed into a whole face by the contralateral hemisphere. With manual responses, the face corresponding to the left half field is selected, but a verbal report would describe the face on the right (Levy *et al.*, 1972). Thus, each hemisphere does, indeed, have its own separate percepts.

The general conclusion that commissure section results in two co-conscious systems running in parallel is not universally accepted, however. Some authorities have maintained that the mind remains unified within the speaking hemisphere or centered in the intact brain stem following commissurotomy, and that the nonspeaking subordinate hemisphere operates as a high-level, but computer-like and unconscious, automaton. Impressions to the contrary are based on subject performance utilizing the mute hemisphere in a variety of tasks. In addition to being able to sense, perceive, learn, and remember, in objective terms, the disconnected minor hemisphere can also center and hold a focus of attention. It can reason nonverbally, make cognitive decisions, and carry out novel volitional actions. It

displays preferences and can act on value priorities. Its performance is superior to the language hemisphere in a series of nonlingual, nonsequential tasks such as discriminations in topological geometry. The mute hemisphere shows typical human emotional responses to affect-laden pictures and other comparable stimuli. The minor hemisphere comprehends spoken instructions at a moderately high level which, according to Zaidel (1973), is only two years below that of the adult language hemisphere on the Peabody Picture Vocabulary Test for single spoken words. The right hemisphere can also read single words and is able to achieve a minimal amount of writing and drawing, as well.

In view of the preceding evidence, claims that the mute hemisphere is not conscious have yielded to intermediate positions, granting the minor hemisphere consciousness at some level, but denying it possession of the awareness especial to the human mind. Accordingly, later tests were directed more specifically at the presence, in the mute hemisphere, of self-consciousness and the higher levels of social awareness (Sperry and Zaidel, 1973). Subjects were presented with an array of pictures or photographs, including items for which the subject could have some familiarity, preference, or distinct emotional response, such as photographs of the subject himself, his family, pets, and other belongings, and public figures. Visual input was continuously lateralized for all directions of gaze with Zaidel's stabilized occluder mounted on a contact lens which allows prolonged study of complex visual material which could not be examined with previously used quick-flash tachistoscopic methods. The kinds of reactions obtained from the mute hemisphere under these conditions strongly indicate a characteristic self- and social awareness that appear essentially normal and are comparable to that of the speaking hemisphere of the same subject. For example, following an initial six trials with relatively neutral stimuli to which the responses had been casual and routine, a middle-aged female subject was presented with a test array of four portraits of herself and the instruction, "Here are four people; again choose the one you like best." The subject exclaimed loudly, "Oh no! Where'd you ....? What are they?". This was followed by a loud laugh and further exclamations including the question, "You're sure there are *people* there?". The possibility of cross-leakage and participation by the speaking hemisphere was eliminated by follow-up questions asking the subject to relate the contents of the photographs. The subject replied, "Something nice, whatever it was", and terminated the trial with another laugh. Although the emotional component of the subject's response crossed rapidly to the speaking hemisphere, presumably through the intact brain stem, the major hemisphere clearly remained unaware of the exact nature of the stimuli that had provoked the response. The emotional outburst evoked by the presentation of the subject's self to the minor hemisphere alone is interpreted to mean that the mute hemisphere does indeed possess a typical human self-awareness, as well as some sense of the subtlety of the subject's role in such a testing situation.

The initial exclamation may have issued from the minor hemisphere prior to interruption by the language hemisphere which thereafter exerted its usual dominant control over the speech apparatus.

Anderson (1974), having accepted the notion of the dual co-conscious state of the hemispheres following commissure section, argues that we should no longer identify or define a "person" as correlating with a body on a one-to-one basis. The necessity to sharpen the concept and definition of "personality" in terms of the critical brain states and neural systems involved follows logically from the commissurotomy data and investigations into the phenomenology of multiple personality.

An extreme position in regard to this concept of personal identity has been taken by Puccetti (1973), a philosopher at Dalhousie, who, along with Bogen (1969), infers that each hemisphere must have a mind of its own not only after brain bisection, but also in the normal intact state. They argue that if commissure section generates a co-conscious system, and hemispherectomy leaves a single person regardless of which hemisphere is removed, then, to begin with, there must be two persons. In other words, our awareness is a function of dual right and left minds, their individuality being unnoticed when the hemispheres work in perfect synchrony. A similar notion regarding the inherent duality of mind was proposed in the 1840s by Wigan (1844).

Dr. Sperry's position with respect to the intact brain has been more conventional, viewing the conscious mind and self as being normally single and unified, mediated by brain activity that typically spans and involves both hemispheres through the commissures. This view implies that the fiber systems of the brain, as well as the gray matter, must mediate the stuff of awareness, and that the fiber cross-connections between the hemispheres are no different in this respect from the fiber systems within each hemisphere. Dr. Sperry's position dates back to the early 1950s when the subjective unity of conscious experience was ascribed not so much to a corresponding spatial/temporal unity of neural activity, or to topological or isomorphic mind-brain correspondency, but rather to a functional effect of the way a given brain process works and operates in the context of brain dynamics. Subjective unity on these terms becomes an organizational or a functional derivative primarily (Sperry, 1952); this concept, in turn, may be seen to imply a functional or causal impact. What evolved, then, was a conceptual explanatory formula for the way that conscious mind could, in principle, move matter in the brain and exert causal influence in the direction and control of behavior (Sperry, 1965; Sperry, 1969). Conscious awareness is interpreted as a dynamic, holistic property of brain activity with causal influence expressed largely in terms of the power exerted by any whole as a system over its component elements--in this case, the power of high order brain events over

the detailed neuronal firing patterns. This interpretation stands in direct contradiction to the central founding precepts of behaviorism and of scientific materialism generally, and yet has survived under repeated examination.

We have recently experienced a shift in the scientific status of consciousness. In the past, neuroscience has treated subjective experience simply as a correlate of brain processes or as a semantic pseudo-problem, and always as a phenomenon without causal influence on the course of physical events in brain function--a phenomenon that objective science could safely ignore. Inner conscious subjective experience, however, is now increasingly recognized as a causal determinant in higher-level psychological functioning. Conscious mental phenomena, on these terms, acquire an important control role in brain function and a reason for having been evolved in a physical system (Sperry, in press). An overall consequence of this change is that many of the more objectionable materialistic, mechanistic, deterministic, and reductionistic aspects of science which the humanist disciplines have always found difficult to accept and relate to, now no longer apply. Science, and particularly behavioral science, looks to become much more mentalistic and humanistic. The shift in recent years toward increased recognition in science of subjective mental experience is referred to variously in psychology as "the humanist, or cognitive, revolution", or simply as "the new psychology". This change in perspective appears to be more than just a matter of changing attitudes in science, or a reflection of general cultural trends; this shift has authentic theoretical support and grounding in fundamental changes taking place in our basic mind-brain concept. Those disciplines in behavioral science which are concerned with subjective experience directly--clinical and cognitive psychology, psychiatry, etc.--acquire a corresponding elevation in the hierarchy of the behavioral sciences. Their standing as separate, distinct disciplines in their own right is reinforced by the contention that the subjective phenomena they deal with are causal and are "different from, more than, and not reducible to" neurophysiology or neurochemistry. In other words, "the meaning of the message will never be found in the chemistry of the ink".

In closing, it is important to caution that none of the theoretical changes involved make subjective experience any easier to work with by scientific methodology. Thus, many of the old arguments against the use of introspection in neuro- and behavioral science still apply. One might also caution that the various legitimate changes toward scientific recognition of mental experience that *are* supported by theory have been accompanied in recent years by a series of corollary side effects, unsupported by theory, which have opportunistically ridden along the wave of new interest in mental phenomena. Mysticism, occultism, astrology, faith healing, and parapsychology

have enjoyed an increased popular acceptance in the past ten years. To the extent that our latest mind-brain concepts are correct, conciousness is interpreted as an emergent property of the living brain in action and, as such, is intimately tied to that organ with all its anatomical and physiological constraints; this interpretation hardly accords with phenomena such as precognition, mental telepathy, psychokinesis, or the presence of mystical domains of conscious experience apart from brain activity.

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